

**$N(2190) 7/2^-$**  $I(J^P) = \frac{1}{2}(7^-)$  Status: \*\*\*\*

Most of the results published before 1975 were last included in our 1982 edition, *Physics Letters* **111B** 1 (1982). Some further obsolete results published before 1984 were last included in our 2006 edition, *Journal of Physics* **G33** 1 (2006).

 **$N(2190)$  BREIT-WIGNER MASS**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>2100 to 2200 (<math>\approx 2190</math>) OUR ESTIMATE</b>			
2180 $\pm 20$	ANISOVICH	12A	DPWA Multichannel
2152.4 $\pm 1.4$	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
2200 $\pm 70$	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
2140 $\pm 12$	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
2140 $\pm 40$	HENDRY	78	MPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
2150 $\pm 26$	SHRESTHA	12A	DPWA Multichannel
2125 $\pm 61$	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
2192.1 $\pm 8.7$	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
2168 $\pm 18$	VRANA	00	DPWA Multichannel
2131	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
2127 $\pm 9$	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$
2180	SAXON	80	DPWA $\pi^- p \rightarrow \Lambda K^0$

 **$N(2190)$  BREIT-WIGNER WIDTH**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>300 to 700 (<math>\approx 500</math>) OUR ESTIMATE</b>			
335 $\pm 40$	ANISOVICH	12A	DPWA Multichannel
484 $\pm 13$	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
500 $\pm 150$	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
390 $\pm 30$	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
270 $\pm 50$	HENDRY	78	MPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
500 $\pm 74$	SHRESTHA	12A	DPWA Multichannel
381 $\pm 160$	BATINIC	10	DPWA $\pi N \rightarrow N\pi, N\eta$
726 $\pm 62$	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
453 $\pm 101$	VRANA	00	DPWA Multichannel
476	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
550 $\pm 50$	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$
80	SAXON	80	DPWA $\pi^- p \rightarrow \Lambda K^0$

**$N(2190)$  POLE POSITION****REAL PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>2050 to 2100 (<math>\approx 2075</math>) OUR ESTIMATE</b>			
2079 $\pm$ 4 $\pm$ 9	<sup>1</sup> SVARC 14	MLS	$\pi N \rightarrow \pi N$
2150 $\pm$ 25	ANISOVICH 12A	DPWA	Multichannel
2070	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$
2042	<sup>2</sup> HOEHLER 93	SPED	$\pi N \rightarrow \pi N$
2100 $\pm$ 50	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
2062	SHRESTHA 12A	DPWA	Multichannel
2063 $\pm$ 32	BATINIC 10	DPWA	$\pi N \rightarrow N\pi, N\eta$
2076	ARNDT 04	DPWA	$\pi N \rightarrow \pi N, \eta N$
2107	VRANA 00	DPWA	Multichannel
2030	ARNDT 95	DPWA	$\pi N \rightarrow N\pi$
2060	ARNDT 91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

**-2 $\times$ IMAGINARY PART**

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>400 to 520 (<math>\approx 450</math>) OUR ESTIMATE</b>			
509 $\pm$ 7 $\pm$ 16	<sup>1</sup> SVARC 14	MLS	$\pi N \rightarrow \pi N$
330 $\pm$ 30	ANISOVICH 12A	DPWA	Multichannel
520	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$
482	<sup>2</sup> HOEHLER 93	SPED	$\pi N \rightarrow \pi N$
400 $\pm$ 160	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
428	SHRESTHA 12A	DPWA	Multichannel
330 $\pm$ 101	BATINIC 10	DPWA	$\pi N \rightarrow N\pi, N\eta$
502	ARNDT 04	DPWA	$\pi N \rightarrow \pi N, \eta N$
380	VRANA 00	DPWA	Multichannel
460	ARNDT 95	DPWA	$\pi N \rightarrow N\pi$
464	ARNDT 91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

 **$N(2190)$  ELASTIC POLE RESIDUE****MODULUS  $|r|$** 

<u>VALUE (MeV)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
54 $\pm$ 1 $\pm$ 3	<sup>1</sup> SVARC 14	MLS	$\pi N \rightarrow \pi N$
30 $\pm$ 5	ANISOVICH 12A	DPWA	Multichannel
72	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$
45	HOEHLER 93	SPED	$\pi N \rightarrow \pi N$
25 $\pm$ 10	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
34	BATINIC 10	DPWA	$\pi N \rightarrow N\pi, N\eta$
68	ARNDT 04	DPWA	$\pi N \rightarrow \pi N, \eta N$
46	ARNDT 95	DPWA	$\pi N \rightarrow N\pi$
54	ARNDT 91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

## PHASE $\theta$

VALUE ( $^{\circ}$ )	DOCUMENT ID	TECN	COMMENT
$-18 \pm 1 \pm 3$	<sup>1</sup> SVARC 14	MLS	$\pi N \rightarrow \pi N$
$30 \pm 10$	ANISOVICH 12A	DPWA	Multichannel
$-32$	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$
$-30 \pm 50$	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
$-19$	BATINIC 10	DPWA	$\pi N \rightarrow N\pi, N\eta$
$-32$	ARNDT 04	DPWA	$\pi N \rightarrow \pi N, \eta N$
$-23$	ARNDT 95	DPWA	$\pi N \rightarrow N\pi$
$-44$	ARNDT 91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

## N(2190) INELASTIC POLE RESIDUE

The "normalized residue" is the residue divided by  $\Gamma_{pole}/2$ .

### Normalized residue in $N\pi \rightarrow N(2190) \rightarrow \Lambda K$

MODULUS (%)	PHASE ( $^{\circ}$ )	DOCUMENT ID	TECN	COMMENT
<b>3 ± 1</b>	<b>20 ± 15</b>	ANISOVICH 12A	DPWA	Multichannel

## N(2190) DECAY MODES

The following branching fractions are our estimates, not fits or averages.

Mode	Fraction ( $\Gamma_i/\Gamma$ )
$\Gamma_1$ $N\pi$	10–20 %
$\Gamma_2$ $N\eta$	(0.0 ± 1.0) %
$\Gamma_3$ $N\omega$	seen
$\Gamma_4$ $\Lambda K$	seen
$\Gamma_5$ $\Sigma K$	
$\Gamma_6$ $N\pi\pi$	seen
$\Gamma_7$ $N\rho$	seen
$\Gamma_8$ $p\gamma$	0.02–0.06 %
$\Gamma_9$ $p\gamma$ , helicity=1/2	0.02–0.04 %
$\Gamma_{10}$ $p\gamma$ , helicity=3/2	0.002–0.02 %

## N(2190) BRANCHING RATIOS

$\Gamma(N\pi)/\Gamma_{total}$	DOCUMENT ID	TECN	COMMENT	$\Gamma_1/\Gamma$
<b>10 to 20 OUR ESTIMATE</b>				
$16 \pm 2$	ANISOVICH 12A	DPWA	Multichannel	
$23.8 \pm 0.1$	ARNDT 06	DPWA	$\pi N \rightarrow \pi N, \eta N$	
$12 \pm 6$	CUTKOSKY 80	IPWA	$\pi N \rightarrow \pi N$	
$14 \pm 2$	HOEHLER 79	IPWA	$\pi N \rightarrow \pi N$	
$16 \pm 4$	HENDRY 78	MPWA	$\pi N \rightarrow \pi N$	

• • • We do not use the following data for averages, fits, limits, etc. • • •

20 ± 1	SHRESTHA	12A	DPWA	Multichannel
18 ± 12	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$
23.0 ± 0.2	ARNDT	04	DPWA	$\pi N \rightarrow \pi N, \eta N$
20 ± 4	VRANA	00	DPWA	Multichannel
23	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
22 ± 1	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$

**$\Gamma(N\eta)/\Gamma_{\text{total}}$   $\Gamma_2/\Gamma$**

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0 ± 1</b>	VRANA	00	DPWA Multichannel

• • • We do not use the following data for averages, fits, limits, etc. • • •

2 ± 1	SHRESTHA	12A	DPWA	Multichannel
0.1 ± 0.3	BATINIC	10	DPWA	$\pi N \rightarrow N\pi, N\eta$

**$\Gamma(N\omega)/\Gamma_{\text{total}}$   $\Gamma_3/\Gamma$**

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>seen</b>	WILLIAMS	09	IPWA $\gamma p \rightarrow p\omega$

**$\Gamma(\Lambda K)/\Gamma_{\text{total}}$   $\Gamma_4/\Gamma$**

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b>0.5 ± 0.3</b>	ANISOVICH	12A	DPWA Multichannel

• • • We do not use the following data for averages, fits, limits, etc. • • •

<1	SHRESTHA	12A	DPWA	Multichannel
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**$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$  in  $N\pi \rightarrow N(2190) \rightarrow \Lambda K$   $(\Gamma_1\Gamma_4)^{1/2}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.02	BELL	83	DPWA $\pi^- p \rightarrow \Lambda K^0$
-0.02	SAXON	80	DPWA $\pi^- p \rightarrow \Lambda K^0$

**$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$  in  $N\pi \rightarrow N(2190) \rightarrow N\rho, S=3/2, D\text{-wave}$   $(\Gamma_1\Gamma_0)^{1/2}/\Gamma$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.13 ± 0.05	SHRESTHA	12A	DPWA Multichannel
-0.25 ± 0.03	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

**$\Gamma(N\rho, S=3/2, D\text{-wave})/\Gamma_{\text{total}}$   $\Gamma_0/\Gamma$**

<u>VALUE (%)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
29 ± 28	VRANA	00	DPWA Multichannel

**$N(2190)$  PHOTON DECAY AMPLITUDES**

Papers on  $\gamma N$  amplitudes predating 1981 may be found in our 2006 edition, *Journal of Physics* **G33** 1 (2006).

**$N(2190) \rightarrow p\gamma$ , helicity-1/2 amplitude  $A_{1/2}$**

<u>VALUE (GeV<sup>-1/2</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.065 ± 0.008	ANISOVICH	12A	DPWA Multichannel

**$N(2190) \rightarrow p\gamma$ , helicity-3/2 amplitude  $A_{3/2}$**

<u>VALUE (GeV<sup>-1/2</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.035 ± 0.017	ANISOVICH 12A	DPWA	Multichannel

**$N(2190) \rightarrow p\gamma$ , ratio of helicity amplitudes  $A_{3/2}/A_{1/2}$**

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-0.17 ± 0.15	WILLIAMS 09	IPWA	$\gamma p \rightarrow p\omega$

**$N(2190) \rightarrow n\gamma$ , helicity-1/2 amplitude  $A_{1/2}$**

<u>VALUE (GeV<sup>-1/2</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.015 ± 0.013	ANISOVICH 13B	DPWA	Multichannel

**$N(2190) \rightarrow n\gamma$ , helicity-3/2 amplitude  $A_{3/2}$**

<u>VALUE (GeV<sup>-1/2</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
-0.034 ± 0.022	ANISOVICH 13B	DPWA	Multichannel

**$N(2190) \quad \gamma p \rightarrow \Lambda K^+$  AMPLITUDES**

**$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$  in  $p\gamma \rightarrow N(2190) \rightarrow \Lambda K^+$  ( $E_{4-}$  amplitude)**

<u>VALUE (units 10<sup>-3</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	
• • • We do not use the following data for averages, fits, limits, etc. • • •			
2.5 ± 1.0	WORKMAN 90	DPWA	
2.04	TANABE 89	DPWA	

**$p\gamma \rightarrow N(2190) \rightarrow \Lambda K^+$  phase angle  $\theta$  ( $E_{4-}$  amplitude)**

<u>VALUE (degrees)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-4 ± 9	WORKMAN 90	DPWA	
-27.5	TANABE 89	DPWA	

**$(\Gamma_i \Gamma_f)^{1/2} / \Gamma_{\text{total}}$  in  $p\gamma \rightarrow N(2190) \rightarrow \Lambda K^+$  ( $M_{4-}$  amplitude)**

<u>VALUE (units 10<sup>-3</sup>)</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-7.0 ± 0.7	WORKMAN 90	DPWA	
-5.78	TANABE 89	DPWA	

**$N(2190)$  FOOTNOTES**

<sup>1</sup> Fit to the amplitudes of HOEHLER 79.

<sup>2</sup> See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of  $N$  and  $\Delta$  resonances as determined from Argand diagrams of  $\pi N$  elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

## N(2190) REFERENCES

For early references, see *Physics Letters* **111B** 1 (1982).

SVARC	14	PR C89 045205	A. Svarc <i>et al.</i>	
ANISOVICH	13B	EPJ A49 67	A.V. Anisovich <i>et al.</i>	
ANISOVICH	12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
BATINIC	10	PR C82 038203	M. Batinic <i>et al.</i>	(ZAGR)
WILLIAMS	09	PR C80 065209	M. Williams <i>et al.</i>	(CEBAF CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
PDG	06	JP G33 1	W.-M. Yao <i>et al.</i>	(PDG Collab.)
ARNDT	04	PR C69 035213	R.A. Arndt <i>et al.</i>	(GWU, TRIU)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman,, T.-S.H. Lee	(PITT+)
ARNDT	95	PR C52 2120	R.A. Arndt <i>et al.</i>	(VPI, BRCO)
HOEHLER	93	$\pi$ N Newsletter 9 1	G. Hohler	(KARL)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KSA) IJP
Also		PR D30 904	D.M. Manley <i>et al.</i>	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt <i>et al.</i>	(VPI, TELE) IJP
WORKMAN	90	PR C42 781	R.L. Workman	(VPI)
TANABE	89	PR C39 741	H. Tanabe, M. Kohno, C. Bennhold	(MANZ)
Also		NC 102A 193	M. Kohno, H. Tanabe, C. Bennhold	(MANZ)
BELL	83	NP B222 389	K.W. Bell <i>et al.</i>	(RL) IJP
PDG	82	PL 111B 1	M. Roos <i>et al.</i>	(HELS, CIT, CERN)
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
SAXON	80	NP B162 522	D.H. Saxon <i>et al.</i>	(RHEL, BRIS) IJP
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
HENDRY	78	PRL 41 222	A.W. Hendry	(IND, LBL) IJP
Also		ANP 136 1	A.W. Hendry	(IND)